International Journal of Civil, Structural, Environmental and Infrastructure Engineering Research and Development (IJCSEIERD)
ISSN(P): 2249-6866; ISSN(E): 2249-7978
Vol. 3, Issue 5, Dec 2013, 99-106

IMPROVE THE PROPERTIES OF CONCRETE BY USING BLOOD AND SILICA FUME

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ABSTRACT

The present investigation consider the effect of blood (ox blood) and silica fume on the mechanical properties of concrete: compressive and splitting tensile strengths. From the test results it can be seen that the use of blood affected negatively in compressive and splitting tensile strength relative to a reference concrete mixes at all ages, the percentages of decreasing in the 28-day compressive and splitting tensile strengths were (34.22and 30.85) % respectively. Therefore, it is concluded that it is not prefer to use blood instead of water in concrete. On the other hand, results showed that there are an increasing in compressive and splitting tensile strength at all ages for concrete mixes prepared using (5 and 10)% silica fume as a percentage addition with weight of cement when compared with a reference concrete. The percentages of increasing in the 28-day compressive strength were (9.38and 25.75)% respectively, in relation to a reference concrete. In the case of the splitting tensile strength the percentages of increasing were (14.84and36.19)% for the addition of (5 and 10)% silica fume respectively. Therefore, it concluded that the best amount of silica fume is (10)%.

KEYWORDS: High Strength Concrete, Silica Fume, Blood in Concrete, Compressive and Splitting Tensile Strengths

INTRODUCTION

Concrete is a construction material composed of cement (commonly Portland cement) and other cementations materials such as fly ash and slag cement, aggregate (generally a coarse aggregate made of gravels or crushed rocks such as limestone, or granite, plus a fine aggregate such as sand), water, and chemical admixtures. The word concrete comes from the laden "concretus" (meaning compact or condensed), the past participle of "concresco" from "com" (together) and "Cresco" (to grow)[1].

Many concrete structures cannot reach their designed service life because of their poor durability water and aggressive substances such as chloride ions are prerequisite to the deterioration of concrete. In aggressive environments, water repellent treatment is an effective path to delay the repair and improve the durability of concrete structures. Thousands of years ago, people used oils, animal fats or wax to treat the surface of natural stones, bricks or put some animal blood in mortar to make water repellent. Also added ox blood in concrete, and investigate the influence of ox blood on compressive strength, water absorption and chloride penetration[2].

The use of blood in the construction industry, according to the invention, is characterized in that the blood is used as air entraining agent and colloid and mixed with the mixture of sand and cement with strong stirring at a concentration of (0.1 to 1.0)% by weight with respect to the weight of said mixture of sand and cement, to obtain a lightened material, such as light colloidal mortar and light colloidal concrete[3]. Silica fume, also known as micro silica, is a byproduct of the reduction of high – purity quartz with coal in electric furnaces in the production of silica and ferrosilicon alloys. Silica fume is also collected as a by- product in the production of their silicon alloys such as ferrochromium, ferromanganese, ferromagnesian, and calcium silicon. Before the mid -1970s, nearly all silica fume was discharged into atmosphere.

After environmental concerns necessitated the collection and land filling of silica fume, it become economically justified to use silica fume in various applications[4,5].

EXPERIMENTAL INVESTIGATION

Materials Used

Cement

The cement used throughout this work was ordinary Portland cement. It is stored in airtight plastic containers to avoid exposure to different atmospheric conditions. The physical test results of the used cement are given in Table (1). It conforms to the Iraqi specification No.5/1984[6].

Table 1: Physical Properties of the Used Cement

Physical Properties	Test Results	Limits of Iraqi Specification No. 5/1984
Specification surface area, Blaine method, (m^2/kg)	314	≥ 230
Soundness (%)	0.22	≤ 0.8
Setting time, Vicat method: Initial setting, hrs : min. Final setting, hrs : min.	 215 3.55	 ≥ 54 min. ≤ 10 hrs.
Compressive strength, (N/mm^2) 3 days 7 days	 20.4 28.7	 ≥ 15 ≥ 23

Fine Aggregate

Natural sand of (4.75 mm.) size with grading limits in zone (3) was used through this investigation. Table (2) illustrates the sieve analysis of fine aggregate. Results indicated that the fine aggregate grading was within the requirement of Iraqi specification No.45/1984[7].

Table 2: Sieve Analysis of Fine Aggregate and Requirements

Sieve Size (mm)	Cumulative Passing (%)	Limits of Iraqi Specification No. 45/1984
4.75	100	90-100
2.36	93.4	85-100
1.18	83.5	75-100
0.60	63	60-79
0.30	21	12-40
0.15	7.3	0-10

Coarse Aggregate

The washed coarse aggregate was uncrushed aggregate of (10 mm.) maximum aggregate size. The sieve analysis of this aggregate is shown in Table (3) .It conforms to the Iraqi specification No.45/1984[7].

Table 3: Sieve Analysis of Coarse Aggregate and Requirements

Sieve Size (mm)	Cumulative Passing %	Limits of Iraqi Specification No. 45/1984
14	100	100
10	88.6	85-100
5	10.8	0-25
2.36	0	0-5

Mixing Water

Ordinary drinking water was used in this investigation for both mixing and curing purposes.

Silica Fume

The type of silica fume was used in this investigation was the sika-fume-HR. It was produced by sika from special Material Trading limited Co. It is a concrete additive of a new generation in powder form with fineness (0.1 μm). The technical data of this type of silica fume was shown in Table (4).

Table 4: Technical Data of the Used Silica Fume

Property	Result
Composition	A latently hydraulic blend of active ingredients.
Appearance	Grey powder.
Dry bulk density	(0.05-01) kg.
Storage	Silica fume is not affected by frost. It must be stored in dry conditions.
Shelf life	24 months from data of production if stored properly in original un opened packing.
Dosage	(2-10)% by weight of cement.
Packaging	15 kg bags. Special packs and bulk silo deliveries also available on request.

Blood

Ox blood was used in this investigation, it was collected from the butcher's shop. Table (5) shows the hematological data of the used blood.

Table 5: Hematological Data of Ox Blood*

Property	Result
Hemoglobin (g/dl)	8.0-15.0
Hematocrit (packed cell volume)%	24.0-16.0
RBC (x 106/μl)	5.0-10.0
MCV (fl)	40.0-60.0
MCH (pg)	11.0-17.0
MCHC (g/dl)	30.0-36.0
RDW (%)	16.7-23.3
Thrombocytes (x103/μl)	100-800
WBC (per/μl)	4000-12000
Neutrophils (mature) (per/μl)	600-1000
Neutrophils (band cells) (Per/μl)	0-120
Lymphocytes (per/μl)	2500-7500
Monocytes (per/μl)	25-840
Eosinophils (per/μl)	0- 2400
Fibronogen (mg/dl)	200-700

*Hematological examination were made in the College of Veterinary Medicine

Experimental Work

The experimental work was planned to investigate the effect of blood and silica fume on compressive strength and splitting tensile strength of concrete. Table (6) shows the details of reference concrete, blood concrete and silica fume concrete used throughout this investigation.

Table 6: Details of the Mixes Used

Mix Designation	Mix Proportions	w/c	Cementitious Materials Content (kg/m^3)	
			Cement	Silica Fume
R	1:1:3	0.4	435	-----------
BC	1:1:3	0.4	435	-----------
SF5	1:1:3	0.4	413.25	21.75
SF10	1:1:3	0.4	391.5	43.5

The experimental work of this investigation consists the following steps:

Preparation of Concrete Samples

The reference concrete mix was designed to have a 28 days characteristic compressive strength of (35) N/mm2 according to the British standard method[8]. Concrete mix with a weight proportions of (1 : 1 : 3) were prepared, and water/cement ratio of (0.40) was used in all mixes, four types of mixes were investigated. Reference concrete (R), Blood concrete (BC), 5% silica fume concrete (SF5) and 10% silica fume concrete (SF10). Silica fume was incorporated as a partial replacement by weight of cement.

Mixing Procedure

A mechanical mixer of (0.1) m3 capacity was used to mix concrete in order to obtain the required workability and homogeneity. For reference concrete, the raw material of cement, sand and gravel were added. The materials were mixed dry in the mixer for about one minute before the required water was added to the mixture. Then the constituents were mixed wet for about three minutes until a homogenous concrete was obtained. For blood concrete, the same steps of arrangement materials in the mixer but added blood instead of water. For concrete containing silica fume as a partial replacement of cement, the materials cement, sand and silica fume were mixed together, then the gravel was added and mixed with mixture before adding water. Finally the water was added and the wet mixture was mixed for about three minutes until a homogenous mixture was obtained.

Testing of Hardened Concrete

The following physical properties of concrete were tested, as follows:

Compressive Strength Test

Based on BS 1881: Part 5: 1983[9], the compressive strength was carried out on (150 * 150 * 150) mm cube specimens. The compressive strength was taken as the average value of three specimens. The rate of loading was about (15) N/mm2 per minute.

Splitting Tensile Strength Test

The splitting tensile strength was conducted on cylinders (150 * 300) mm. The average of three test specimens was taken. The test was carried out in accordance with ASTM C496-04[10].

RESULTS AND DISCUSSIONS

The compressive and splitting tensile strengths developed at various curing ages for all type of concrete are presented in Table (7) and illustrated in Figures (1 to 4). Results indicated that for the same mix, all concrete specimens exhibited continuous increasing with the increasing in the curing age. From Table (7), the compressive and splitting tensile strengths of blood concrete decreases with the addition of blood instead of water in the mix. Also, it can be seen that the addition of (5 and 10)% silica fume causes increase in the compressive and splitting tensile strengths of concrete at 28 days. The percentage of decreasing in the 28-day compressive and splitting tensile strengths of blood concrete compared with the reference concrete mix were (34.22 and 30.85)% respectively. The percentage of increasing in the 28-day compressive strength of concrete with (5 and 10)% silica fume by weight of cement were (9.38 and 25.75)% respectively. Also, the percentage of increasing of splitting tensile strength of concrete with (5 and 10)% silica fume by weight of cement were (14.84 and 36.19)% respectively. This is due to that the silica fume improves the concrete in two ways:

The basic pozzolanic reaction, and the micro filler effect.

The addition of silica fume improves bonding within the concrete. It is also combines with the calcium hydroxide (C-S-H) produced in the hydration of Portland cement to improve concrete durability. As a micro filler, the extreme fineness of the silica fume allows it to fill the microscopic voids between cement particles. This greatly improves the paste to aggregate bond of the resulting concrete compared with the reference concrete mix.

Table 7: Compressive Strength and Splitting Tensile Strengths for various Types of Concrete

Mix Designation	Cement Content (kg/m^3)	Silica Fume (%)	Compressive Strength (N/mm^2)			Splitting Tensile Strength (N/mm^2)		
			7 Day	14 Day	28 Day	7 Day	14 Day	28 Day
R	435	----	25.26	34.12	41.75	3.15	3.78	4.31
BC	435	----	17.13	24.45	27.46	2.11	2.76	2.98
SF5	413	5	30.12	38.45	45.67	3.91	4.22	4.95
SF10	391	10	35.61	40.18	52.44	4.45	4.9	5.87

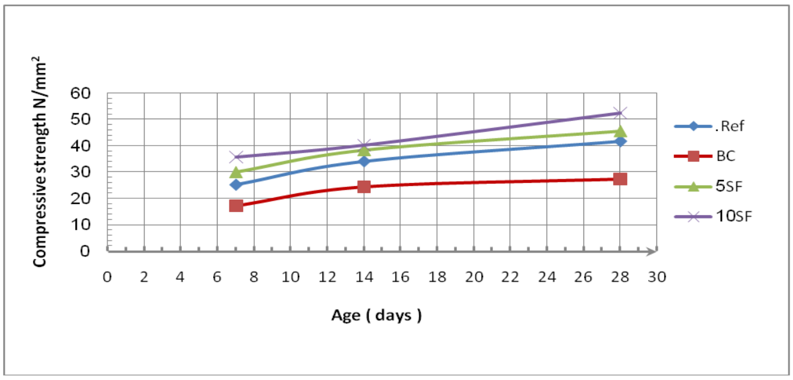

Figure 1: 28-Day Compressive Strength for All Type of Concrete

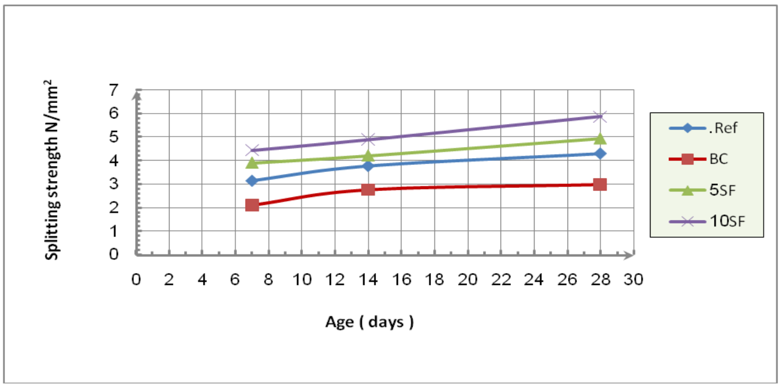

Figure 2: 28-Day Splitting Tensile Strength for All Type of Concrete

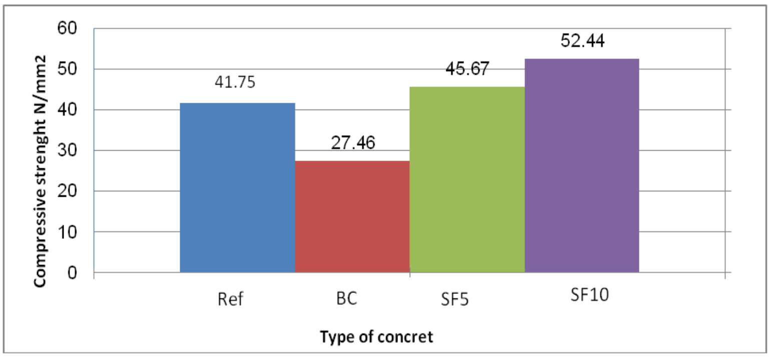

Figure 3: 28-Day Compressive Strength of various Types of Concrete

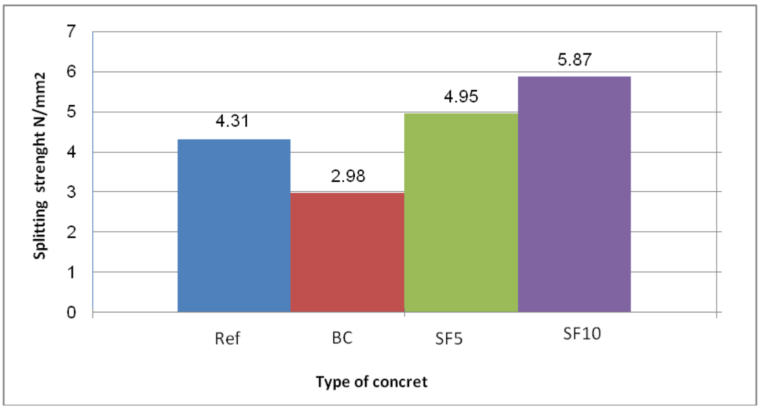

Figure 4: 28-Day Splitting Tensile Strength of Various Types of Concrete

CONCLUSIONS

Depending on the results of the existing investigation, the following conclusions may be drawn:

- Test results indicated that, concrete containing blood instead of water have a lower compressive and splitting tensile strengths at all ages of curing compared with the reference concrete mixes. The percentages of decreasing in the 28-day compressive and splitting tensile strengths were (34.22 and 30.85)% respectively.
- The addition of silica fume (5 and 10)% by weight of cement to the reference concrete leads to an increase in the compressive and splitting tensile strengths of concrete. The percentages of increasing in the compressive strength at 28 days were (9.38 and 25.75)% respectively.
- The percentage of increasing in the splitting tensile strength of concrete at 28 days age with (5 and 10)% silica fume by weight of cement were (14.84 and 36.19)% respectively.
- The compressive and splitting tensile strengths are related to each other but there is no direct proportionality between them. On the other hand, the splitting tensile/compressive strength ratio depends on the curing ages, the type of the admixture, and the general level of strength of concrete.

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